Crucible Data Sheet

CRUCIBLE XM 19 Stainless is a nitrogen strengthened, low carbon, austenitic stainless steel that provides good corrosion resistance in combination with high strength. The alloy has better corrosion resistance than Type 316 with approximately twice the yield strength. It can be welded, machined and cold worked using the same equipment and methods used for the conventional 300 series stainless steels. It is nonmagnetic as annealed and after severe cold work.

Applications

It is expected that the excellent combination of strength, ductility, toughness, corrosion resistance and fabricability will make the alloy suitable for applications such as pumps, valves and fittings for chemical and petrochemical equipment, fasteners, cables, chains, screens, wire cloth, marine hardware, boat shafting, heat exchanger parts, springs and photographic process equipment. Additionally, the alloy has good toughness at cryogenic temperatures and relatively high tensile and yield strengths at moderately high elevated temperatures. These properties further increase the versatility and usefulness of the alloy.

Note: The above are some *typical* applications. Your *specific* application should not be undertaken without independent study and evaluation for suitability.

Specifications

CRUCIBLE XM 19 stainless steel has the UNS Designation S20910 and is included in the following specifications:

ASTM A182	ASTM A479	NACE MR 01-75
ASTM A193	ASTM A580	1980 Addenda
ASTM A194	AMS 5764	
ASTM A276	AMS 5861	

CRUCIBLE XM 19 STAINLESS STEEL

Issue #2

Carbon	0.03% max.
Manganese	4.0/6.0%
Silicon	1.0% max.
Phosphorous	0.040% max.
Sulfur	0.030% max.
Chromium	20.5/23.5%
Nickel	11.5/13.5%
Molybdenum	1.5/3.0%
Columbium	0.10/0.30%
Vanadium	0.10/0.30%
Nitrogen	0.20/0.40%
Iron	Balance

Cold Working

CRUCIBLE XM 19 Stainless can cold formed by drawing, bending, upsetting and stamping. Because of its higher strength and work hardening rate, the force required is somewhat greater than for Types 302, 304, and 316. However, the same equipment and fabrication techniques can be used. The high work hardening rate can be advantageous when cold working to increase strength; i.e., high strengths with good ductility can be achieved with less reduction.

Hot Working

CRUCIBLE XM 19 Stainless can be forged, hot rolled, hot headed and upset. An initial forging temperature of 2100/2200F (1149/1204C) is normally used. Preheating

Note: Temperatures shown throughout this data sheet are steel temperatures.

to an intermediate temperature is not required and forgings can be rapidly cooled without danger of cracking. For best corrosion resistance, anneal after forging.

Annealing

Heat to 1950/2050F (1066/1121C) and cool rapidly. Thin sections are usually cooled in air and heavy sections in water.

Welding

The alloy is weldable by a number of conventional methods. Weld joints with the strength of the base metal can be obtained. When using a filler metal, a high nitrogen austenitic stainless steel, CRUCIBLE XM 19, is required to obtain high weld strength. Where lower weld strength is acceptable, Type 316L can be used.

Cleaning

The oxide scale during hot working and annealing can be removed by grinding, machining, grit blasting or acid pickling. The following procedure for acid cleaning is effective.

Immerse in a solution of 10-15 volume percent nitric acid plus 1-2 percent hydrofluoric acid at 100/130F (38/54C) for 10-15 minutes or until clean. Water rinse and immerse in 20 volume percent nitric acid at room temperature for 5 minutes and water rinse.

Physical Properties

Density		
lb/in^3 (75F)		0.285
kg/m^3 (24C)		7889
Specific gravity		7.88
Coefficient of thermal expansion		
10^{-6}/F (70/200F)		9.0
K^{-1}(21/93C)		16.2
10^{-6}/F (70/800F)		9.9
K^{-1}(21/427C)		17.8
10^{-6}/F (70/1600F)		11.1
K^{-1}(21/871C)		20.0
Thermal conductivity	Btu-in-ft^2•hr•F	W/m•K
300F (149C)	108	15.6
900F (482C)	141	20.3
1500F (816C)	175	25.2
Electrical resistivity (RT)		
ohms-cir mil/ft		493
microhm-mm		820
Magnetic permeability (field strength 200 oersteds)		
Annealed condition		1.004
Cold drawn 27% (wire)		1.004
Cold drawn 75% (wire)		1.004

Corrosion Resistance

CRUCIBLE XM 19 has good corrosion resistance in many reducing and oxidizing acids, chlorides and pitting environments. In five percent sodium chloride spray at 95F and based on the amount of rusting, CRUCIBLE XM 19 is superior to Type 316 stainless. In a ten-day room temperature 10 percent ferric chloride solution test, CRUCIBLE XM 19 displayed a 0.002 gram weight loss; Type 316 stainless, 1.1 grams. Typical corrosion rates for CRUCIBLE XM 19 in comparison to Type 316 stainless are shown in Figure 1. In particular, the alloy provides an excellent level of resistance to pitting and crevice corrosion in seawater; tests have shown it to be completely unaffected after 9 months in quiet seawater. Resistance to intergranular attack in boiling 65% nitric acid and in ferric sulfate-sulfuric acid (Streicher test) is excellent for both the annealed and sensitized conditions. Like other austenitic stainless steels, CRUCIBLE XM 19, under certain conditions may stress corrosion crack in hot chloride environments. CRUCIBLE XM 19 has excellent resistance to sulphide stress cracking when tested in the NACE recommended synthetic sour well solution (5% NaCl + 1% Acetic Acid saturated with H_2S).

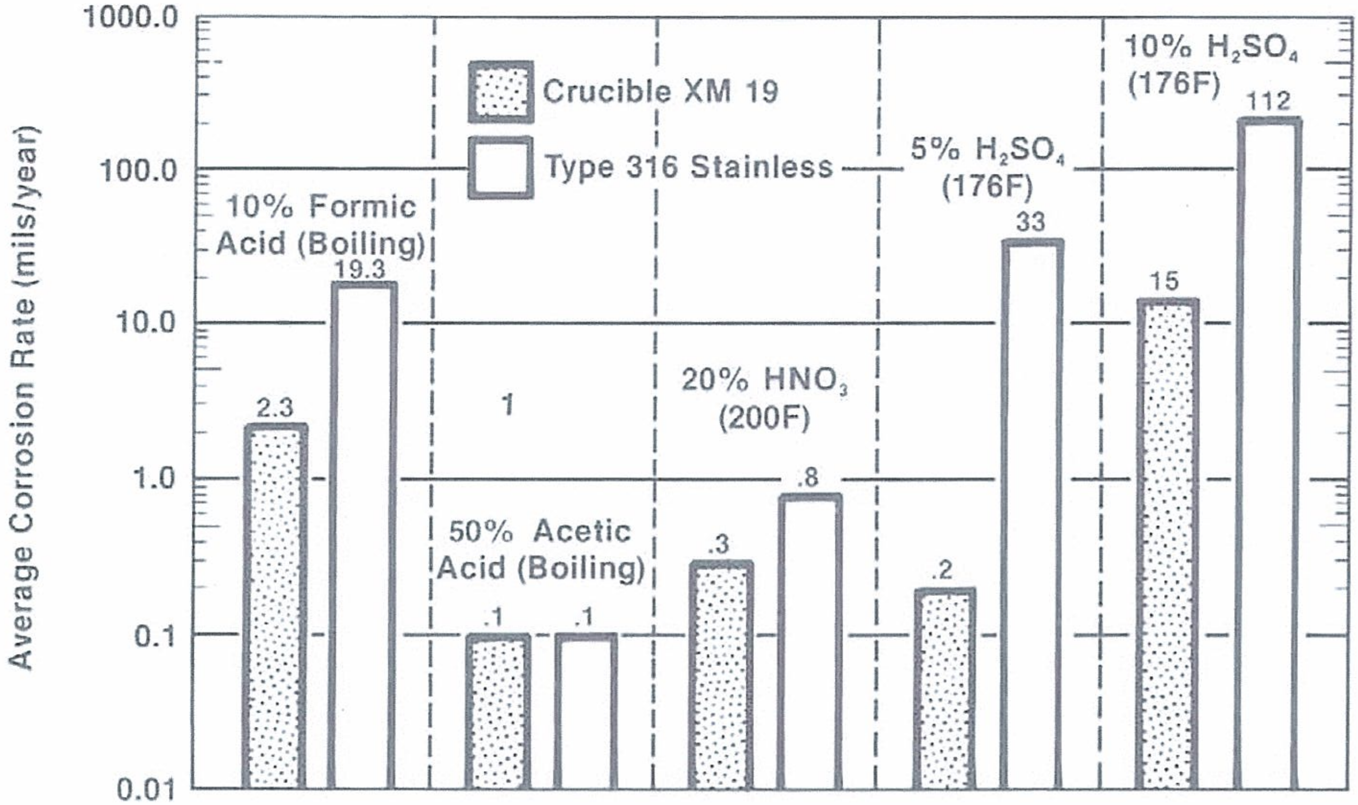


FIGURE 1. CORROSION DATA ON ANNEALED MATERIAL

Machining

CRUCIBLE XM 19 has a machinability rating about 35% of AISI B1112, or 70% of Type 316. Slow to moderate speeds, moderate feeds and rigid tools are recommended; tools must be kept sharp. Chips tend to be tough and stringy. Chip curlers or breakers are helpful. Use a sulfurized cutting fluid, preferably of the chlorinated type. Machining suggestions are given in the following tables.

Turning—Single Point and Box Tools

High Speed Steel Tool				Carbide Tool		
Depth of Cut Inches (mm)	Speed sfpm (m/s)	Feed ipr (mm/r)	Tool Material	Speed sfpm (m/s)	Feed ipr (mm/r)	Tool Material
0.150 (3.81)	55 (0.28)	0.0035 (0.09)	M2, T5, T15	165 (0.83)	0.012 (0.30)	C-2
0.1025(0.64)	70 (0.35)	0.0050 (0.13)	M2, T5, T15	220 (1.10)	0.007 (0.18)	C-3

Turning—Cutoff and Form Tools
Feed—Inches per Revolution

	Cutoff Tool Width—Inches (mm)			Form Tool Width—Inches (mm)					
Speed sfpm (m/s)	0.062 (1.57)	0.125 (3.18)	0.250 (6.35)	0.500 (12.70)	0.750 (19.05)	1.00 (25.4)	1.50 (38.1)	2.00 (50.8)	Tool Material
60 (0.30)	0.001 (0.03)	0.0015 (0.04)	0.002 (0.05)	0.0015 (0.04)	0.0015 (0.04)	0.001 (0.03)	0.001 (0.03)	0.007 (0.02)	M2, T5, T15
140 (0.70)	0.003 (0.08)	0.003 (0.08)	0.0045 (0.11)	0.003 (0.08)	0.0025 (0.06)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	C-6 Carbide

Drilling
Feed—Inches per Revolution (mm/r)

	Hole Diameter—Inches (mm)						
Speed sfpm (m/s)	1/8 (3)	1/4 (6)	1/2 (13)	3/4 (19)	1 (25)	1-1/2 (38)	Tool Material
45 (0.23)	0.0015 (0.04)	0.0025 (0.06)	0.0030 (0.08)	0.035 (0.09)	0.004 (0.10)	0.045 (1.14)	M33 T15

Reaming (Finishing)
Feed—Inches per Revolution (mm/r)

	Hole Diameter—Inches (mm)			
Speed sfpm (m/s)	1/4 (6)	1/2 (13)	1 (25)	1-1/2 (38)
30 (0.15)	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)

Tapping

Speed sfpm (m/s)	Tool Material
15 (0.08)	M10, M7, M1

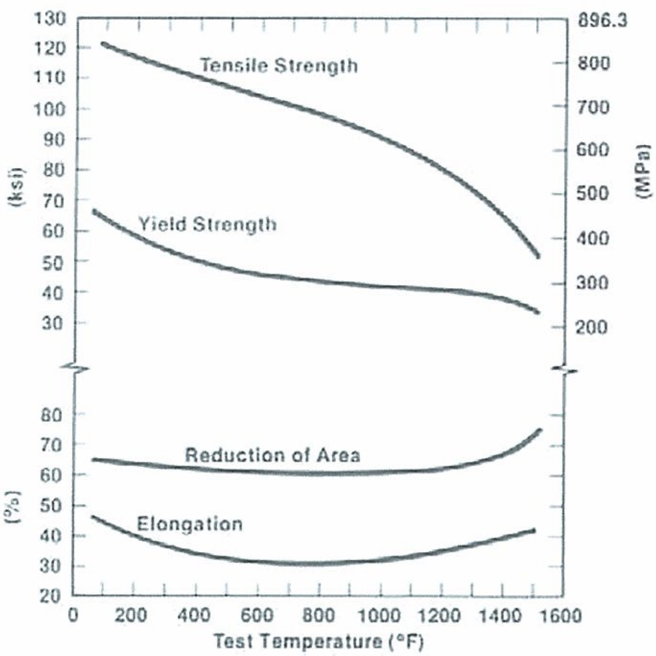
Specific machining parameters can be obtained from Crucible Technical Services.

Typical Mechanical Properties

Room Temperature—Annealed One Inch Round Bar

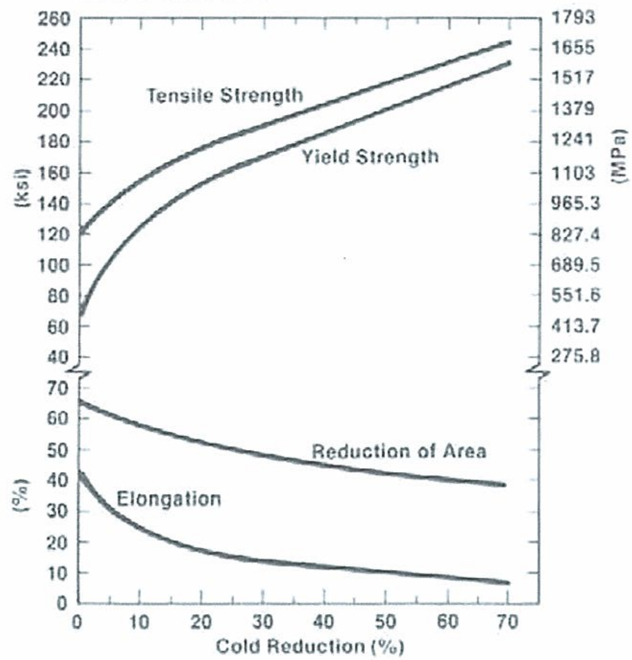
Tensile Strength—psi (MPA)	120,000 (827)
0.2% Yield Strength—psi (MPA)	65,000 (448)
Elongation in 2 in. (50.8 mm)—%	45
Reduction in Area—%	65
V-Notch Charpy Impact—ft. lbs. (J)	160 (217)
Hardness—RB	96

**Elevated Temperature—
Annealed One Inch Round Bar**



Elevated temperature properties of annealed one-inch round bar

**Room Temperature—
Cold Drawn Wire**



Room temperature mechanical properties of cold drawn wire

Sub-Zero-Annealed One Inch Round Bar

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		% Elongation	% Reduction of Area	V-Notch Charpy Impact	
°F	°C	ksi	MPa	ksi	MPa			ft-lbs	J
-100	- 73	85	586	146	1007	50	65	115	156
-320	-196	128	883	226	1558	40	50	50	68

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and conditions of heat treatment may cause deviations from these values.

Crucible Industries

Crucible Industries LLC

575 State Fair Blvd., Solvay, NY 13209
www.crucible.com
800-365-1180 315-487-4111